TACTICAL CONTROL SYSTEM PROGRAM

TACTICAL CONTROL SYSTEM
MISSION PLANNER CRITERIA DOCUMENT

Version 1.2.1
1 October 1997

Changes from previous version

Added Requirements:

C-45

Modified Requirements:

C-10, C-19, C-22, C-23, C-25, C-26, C-34, C-42

Deleted Requirements:

None

Priority Changes:

None

Table of Contents

1. Introduction

This section describes the required controls and operations of the route planning module and the payload control module. Each criteria has been assigned a priority of high (H), medium (M), low (L) or not scored (NS), depending on its criticality; the priority designator may be found in brackets preceding the criteria item. Criteria are identified as either Minimum Criteria (MC) or Criteria (C) followed by an integer value for reference purposes; each criteria is followed by its ID number in brackets.

Mission planning includes both Aerial Vehicle (AV) flight operations and payload operations. A mission plan display consists of waypoints and flight segments between waypoints. Waypoints consist of coordinates, altitude and airspeed. Payload actions may also be specified for a waypoint (e.g. payload pointing commands). Waypoints are numbered consecutively in the order the AV is to fly to them. A flight segment consists of the flight route between two consecutive waypoints. A flight corridor is a defined region about the flight route which allows for deviations in the actual flight path (due to the Global Positioning System (GPS) errors, wind, etc.).

2. Minimum Criteria

The mission planner must meet all of the minimum criteria in order to be considered for selection.

2.1 Route Planning Software

Route planning software operational on specified TAC-4 and CHS-II [MC-2]

The planner will be operational on the TAC-4 (Hewlett Packard HP9000/J210 with 320 MB memory) with the HP-UX 10.20 operating system and on the CHS-II (Sun Sparc 20 Model 152 MP with 256 MB memory) with the Solaris 2.5.1 operating system.

Applicable to fixed wing aircraft [MC-4]

The planner will support fixed wing aircraft (Predator, Outrider, Pioneer (growth)).

Capable of supporting different fixed wing aircraft by changing the air vehicle related data [MC-5]

The planner will support different fixed wing aircraft by changing the air vehicle related data.

Use of Chart (which is part of Joint Mapping Tool Kit (JMTK)) for Map loading/unloading/manipulation [MC-10]

Use Chart (which is part of JMTK) for map loading/unloading/manipulation.

Using Chart, the planner can import, via operator procedure, the following compact disk National Imagery and Mapping Agency (NIMA) data:

Digital Terrain Elevation Data (DTED)
Digital Feature Analysis Data (DFAD)
Arc Digitized Raster Graphic (ADRG)
Vector format
Compressed ADRG (CADRG)

Use of Chart also allows for map functionalities such as pan/scroll, zoom in/out, center, cursor coordinate display, and range and bearing calculations.

Integrate with the TCS data server [MC-11]

The planner will be able to pass mission data to the TCS data server so that TCS can construct a mission plan and transmit this plan to the AV. The planner will also be able to receive current AV status for use in mission planning (e.g., if the AV is retasked, current AV fuel will be used to validate that the AV has enough fuel to fly the new mission).

2.2 **Payload Planning Software**

Payload planning software operational on a specified TAC-4 and CHS-II [MC-7]

The planner will be operational on the TAC-4 (Hewlett Packard HP9000/J210 with 320 MB memory) with the HP-UX 10.20 operating system and on the CHS-II (Sun Sparc 20 Model 152 MP with 256 MB memory) with the Solaris 2.5.1 operating system.

Capable of planning an Electro-Optical/Infrared (EO/IR) mission [MC-9]

The planner will be capable of planning an EO/IR payload mission.

3. **Additional Criteria**

3.1 **System Constraints**

[H] *Distributable to Department of Defense (DoD) sites worldwide and to foreign nationals* [C-1]

All algorithms and software used in the development of the Tactical Control System (TCS) will be distributable to DoD sites worldwide and to foreign nationals.
[NS] *Interoperable with Tactical Aircraft Mission Planning System (TAMPS) and/or Air Force Mission Support System (AFMSS) and/or Aviation Mission Planning System (AMPS)* [C-2]

The planner will be interoperable with the force level mission planning systems TAMPS - Navy/Marine Corps, AFMSS - Air Force, and AMPS - Army.

[H] *Defense Information Infrastructure (DII) Compliant* [C-3]

The planner will be DII compliant (to at least level 6).

[M] *Documentation available* [C-5]

The following documentation for the planner will be provided:

- Operator's Manual
- Software Design Document
- Software Requirements Document
- TCS Integration Procedures
- Software Version Description Documents

3.2 Software Requirements

3.2.1 General Requirements

[H] *Unlimited rights for route and payload planning software* [C-41]

The TCS program will have unlimited rights to all algorithms and software used in the route and payload planner.

[M] *Integrated or separate route and payload planning* [C-6]

The planner will permit route planning and payload planning to be performed as an integrated process or as separate processes. As separate processes payload planning could be performed first, then route planning could be added later -- or the converse.

[H] *Replan route or payload tasking during all phases of operational mission execution (dynamic retasking)* [C-7]

The planner will provide the capability to dynamically retask the AV and payload during all phases of operational mission execution, including modifying or replacing mission plans while the AV is airborne.

[M] *AV model for use in planning and validation* [C-8]

The planner will utilize an AV model for use in planning and validation. At a minimum, this model will determine AV flight performance and fuel usage as a function of AV weight, altitude and airspeed.

[L] *Hardcopy route planning data* [C-9]

Upon operator command, the planner will generate hard copy printouts of the route planning data in text or tabular format.

Upon operator command, the planner will generate hard copy printouts of the route planning data via screen captures.

[M] *Multiple systems of units and coordinate systems available* [C-10]

The planner will allow the operator to select either Standard English or Metric as the system of units for the purpose of entering, displaying, and recording data. Note: This part of the criteria will not be scored.

The planner will allow the operator to select Latitude/Longitude (Lat./Lon.), Universal Transverse Mercator (UTM), or Military Grid Reference System (MGRS) as the coordinate system for the purposes of entering, displaying, and recording data.

[NS] *Distributed Tasking* [C-11]

The planner will allow mission planning related data/files to be transferred between TCS stations before and during AV flight. Use of this capability will include activities such as partial mission planning on one TCS - mission plan completion on another TCS

[L] *Data Entry Validation* [C-12]

Upon the entry of each data value by the operator, the planner will validate the entered value is contained within the acceptable range and prompt the operator to correct any illegal values.

[H] *Store/retrieve/delete mission plans* [C-13]

Upon operator command, the planner will store mission plans under unique names to allow for future retrieval.

Upon operator command, the planner will retrieve mission plans for viewing or modification.

Upon operator command, the planner will delete selected mission plans.

[M] *Tailor displays based on selected AV type* [C-43]

The displays will be tailored to match the functionality associated the selected AV and payload type. For example, when planning a Predator mission, functionality that is Outrider specific will not be displayed.

3.2.2 **Create/Modify Mission Plans**

3.2.2.1 **Mission Planning Tools**

[M] *Flight profile vs. terrain profile display (using DTED)* [C-14]

Using DTED, the planner will graphically display the AV flight profile against the profile of the terrain.

[M] *Datalink coverage overlay (using DTED)* [C-15]

Based on an operator-selected AV altitude and type of Ground Data Terminal (GDT), the planner will create and display a map overlay that geographically depicts areas where the datalink Line of Sight (LOS) is occluded by the terrain (i.e., datalink coverage overlay). The planner will use DTED data to determine the area of occlusion.

[L] *Threat area overlay* [C-16]

The planner will be capable of creating and modifying threat data bases. The threat ranges will be calculated, based on specified AV altitude, and the threat areas will be displayed as an overlay.

[M] Recovery basket overlay [C-44]

The planner will display the recovery basket associated with a mission. This overlay will be used to determine where a ship must be to recover a UAV after the completion of its mission.

3.2.2.2 **Route Planning**

The planner will store default values for mission planning parameters providing the operator the capability to review and change them.

Note: The units in parentheses are the preferred units for each data entry.

[H] *Parameter initialization: Environmental parameters* [C-17]

Environmental parameters at varying altitudes will be imported from external sources or entered by the operator. This set of data will include the following:

Wind velocity (knots)
Wind heading (degrees)
Temperature (degrees Fahrenheit)
Visibility (miles)
Barometric pressure (millibars)
Humidity (percent)

[H] *Parameter initialization: AV/Payload parameters* [C-18]

The planner will allow the operator to select a type of AV (Predator, Outrider, Pioneer (growth)).

The planner will store AV performance/characteristic profiles for each type of AV. The operator may select an existing profile or create a new one. At a minimum, the profile will contain the following data about the AV:

- AV identifier (alphanumeric)
- Text field (for operator entry of remarks, data revision number, etc.)
- AV empty weight, includes fixed payloads (pounds)
- Defined payloads (EO/IR, SAR)
- Payload weights (pounds) (EO/IR, SAR)
- Maximum altitude (feet)
- Stall speed (knots)
- Maximum airspeed (knots)
- Climb rate (feet/minute) (climb rate as a function of altitude, weight and airspeed)
- Descent rate (feet/minute) (descent rate as a function of altitude, weight and airspeed)
- Fuel usage characteristics (pounds/hour) (fuel consumption rate as function of cruise/climb/descent, altitude, weight and airspeed)
- Fuel weight per unit (e.g., kilograms per liter)
- Fuel tank capacity (pounds, liters)
- Datalink range (nautical miles or kilometers) with respect to GDT/ADT type

[H] *Parameter initialization: Mission parameters* [C-19]

Mission parameters will be entered by the operator. This set of data will include the following:

- Type of AV (Predator, Outrider, Pioneer (growth))
- AV identifier (alphanumeric)
- Mission ID (filename)
- Launch time (year:month:day:hour:minute)
- Launch point (Lat/Lon, UTM, MGRS)
- Recovery point (Lat/Lon, UTM, MGRS)
- Route corridor width, used for terrain clearance validation (nautical miles)
- Sensor package/payload (EO/IR, SAR)
- Fuel reserve (pounds, liters)

The following default flight information will be stored and may be changed by the operator:

- Amount of fuel (pounds, liters)
- Airspeed upper limit (knots)

Airspeed lower limit (knots)
Airspeed (knots)
Terrain clearance altitude margin (feet)

[H] *Fuel, distance and time calculations* [C-20]

The planner will compute the fuel remaining at each waypoint.

The planner will compute the distance of each flight segment and the entire flight path.

The planner will compute the estimated time of arrival at each waypoint and the total flight time of the entire flight path.

[H] *Waypoint and flightpath graphical displays* [C-21]

The planner will display the waypoints and flightpath for the mission plan using graphical displays on a map.

[H] *Waypoint creation/movement/deletion* [C-22]

The planner will allow alphanumeric entry for waypoint creation/movement.

The planner will allow point and click waypoint creation/movement/deletion. This includes point and click creation/movement of the flight segment arc associated with the Outrider's Arcs Fly-to-waypoint mode.

[H] *Waypoint information definition (Predator)* [C-23]

The planner will allow alphanumeric entry and display of the following Predator waypoint information:

Waypoint number (automatically generated)
Coordinates (Lat/Lon, UTM, MGRS)
Airspeed command (knots)
Auto Pilot Airspeed Mode(s) (Indicated Airspeed)
Altitude command (feet)
Auto Pilot Altitude Modes (Baro MSL)
Loiter time (hours:minutes)
Loiter pattern (None, N-Gon 6 points, Figure 8)
Loiter pattern heading (degrees)
Loiter pattern size (2-dimensional scaling)
Video Cassette Recorder (VCR) control (Pause, Record)
UAV VCR Video Source Review (Nose, Camera 1, EO 2 - Daylight, FLIR, EO 1 - Spotter, Receiver)
Loss of Link Command (Continue to next waypoint, Re-acquire / go to emergency route)

Return to Base Action (Forward through entire plan, Emergency Route)
Payload commands (as defined in Section 3.2.2.3)
Communication commands (as defined in Section 3.2.2.4)

[H] *Waypoint information definition (Outrider)* [C-45]

The planner will allow alphanumeric entry and display of the following Outrider waypoint information:

Waypoint number (automatically generated)
Fly-to-waypoint mode (Arcs, Heading, Lines, Points)
Coordinates (Lat/Lon, UTM, MGRS)
Arc Angle (for Arcs Fly-to-waypoint mode)
Airspeed command (knots)
Altitude command (feet)
Loiter pattern (None, Fixed Racetrack, Relative Racetrack - Points Mode, Relative Racetrack - Arcs Mode)
Loiter time (number of loops)
Loiter pattern size (forward and right leg from loiter center to first point in loiter pattern)
Loiter airspeed command (knots)
Loiter altitude command (feet)

[L] *Route optimization* [C-24]

Upon operator command, the planner will run an optimization algorithm to minimize the total fuel consumption for a route.

Upon operator command, the planner will run an optimization algorithm to determine the best route for the AV to avoid restricted/threat zones.

Upon operator command, the planner will run an optimization algorithm to determine the best route for the AV to minimize the threat to the AV when it must enter threat zones for mission critical needs (e.g., for data collection).

3.2.2.3 **Payload Planning**

[M] *Plan Synthetic Aperture Radar (SAR) missions* [C-25]

The operator will be able to plan reconnaissance SAR missions. The operator will be able to enter an image identification number.

The planner will allow the operator to designate SAR collection strips (Mode 2 for the Predator SAR), which are defined by beginning and end point coordinates (Lat/Lon, UTM, MGRS). The planner will determine the altitude (using DTED) at spaced points

(with 100 meter spacing) along the SAR collection strip. The operator will be able to enter image resolution (meters).

The planner will display the portion of each flight segment associated with SAR imagery collection. These SAR collection segments will be visually distinct from the rest of the flight segment.

[H] *EO/IR payload control* [C-26]

The planner will allow the operator to control the EO/IR payload by entering the following commands:

Sensor selection (IR, EO1, EO2)
Zoom setting (if EO1, then 0; if EO2, then 0 to 100)
IR Field of View (None, 2X; 19 MM, 70 MM, 280 MM)
IR Image Polarity (White hot, Black hot)

[H] *Payload pointing commands* [C-27]

The planner will allow the operator to select the EO/IR payload mode (Point to coordinate, Fixed orientation)

The planner will allow the operator to point the EO/IR payload to a particular location for any mission plan waypoint(s) by entering the following data:

Coordinates (Lat/Lon, UTM, MGRS)
Altitude (feet) (default to DTED altitude at pointing coordinates)

The planner will allow the operator to point the EO/IR payload in a particular orientation for any mission plan waypoint(s) by entering the following data:

Azimuth (Reference to nose of vehicle, clockwise is positive)
Depression angle (reference to wing plane, positive is down)

[L] *Payload search visual acuity range* [C-28]

The planner will determine the EO/IR payload visual search acuity range based on environmental parameters.

The planner will determine lunar and solar terrain shadowing based on DTED data and the position of the sun and moon.

[H] *Payload FOV swath display* [C-29]

Upon operator command, the planner will display the search footprint of the payload on a map to indicate the predicted payload FOV swath covered during the mission.

3.2.2.4 **Communications Planning**

[M]*Communications planning* [C-42]

The planner will generate a communications plan that will specify the following information:

Location of GDT(s) used to control the AV (Lat/Lon, UTM, MGRS)
Datalink(s) used to communicate with the AV (LOS, Ku Band)
Satcom channel number (0 to 100)
Communication satellite longitude
Communication frequency (240 to 16000 Khz)
Identify Friend or Foe (IFF) command (Off, On)
Squawk Code (0 to 7777 oct)

The planner will determine the area in which the GDT has LOS datalink coverage of the entire flight path and depict this area as a map overlay. (This overlay could be used to determine where a ship may move during the mission flight without violating LOS datalink constraints.)

3.2.3 **Create Emergency (Return Home) Plan**

[H] *Waypoint and flightpath graphical displays* [C-30]

The planner will display the waypoint and flight path for an emergency (return home) plan using graphical displays. This display should be the same as for a non-emergency mission plan but be visually distinct in at least two ways (e.g., different colors and different type of lines to indicate that it is an emergency plan.)

[H] *Waypoint creation/movement/deletion* [C-31]

The planner will allow alphanumeric entry for waypoint creation/movement.

The planner will allow point and click waypoint creation/movement/deletion.

3.2.4 **Validate Mission Plan**

[H] *Valid mission plan definition* [C-32]

The planner will perform validation checks (described in Section 3.2.4) on a mission plan prior to uplinking the mission plan to an AV.

If the mission plan passes all of the validation checks, the planner will consider the plan valid and inform the operator. The plan may be uplinked to the AV.

If the mission plan fails any validation check, the planner will consider the plan invalid and inform the operator why it failed (what check(s) failed and where in the plan the failure(s) was/were detected).

- The planner will provide the operator with the capability to override the failure(s). If the operator overrides all failures in a mission plan, the plan may be uplinked.

- If the operator does not override all failures in a mission plan, the plan may not be uplinked.

[NS] *Weight and balance take off checks* [C-33]

Using the empty weight of the AV, the payload weight (including any counter balance weights) and the fuel weight at takeoff, the planner will automatically verify the AV weight and balance do not violate takeoff constraints.

[H] *Automatic safeguards to prevent unsafe flight* [C-34]

Using DTED, the planner will perform a terrain clearance analysis of the selected route corridor to ensure the AV maintains an adequate altitude margin (to avoid surface impact).

The planner will perform fuel consumption calculations to ensure there will be sufficient fuel to complete the mission and recovery with fuel reserve.

Using DTED and threat range data, the planner will perform threat exposure analysis of the route corridor to ensure the AV will not be vulnerable to known threats.

Using DTED and air traffic restriction data, the planner will perform analysis of the route corridor to ensure the AV will not enter restricted zones.

[M] *Mission plan achievability* [C-35]

The planner will perform a check to ensure all desired flight actions are within the AV performance envelope.

The planner will perform a check to ensure the mission plan is possible given the environmental conditions. (For example, if the wind velocity is too high, the AV cannot maintain a loiter pattern.)

The planner will perform a check to ensure the mission plan is possible given the estimated time of execution of the mission plan.

[H] *Datalink constraints: LOS visibility check* [C-36]

Using DTED, the planner will perform a terrain clearance analysis to ensure the AV will maintain datalink LOS throughout the route corridor.

[L] *Datalink constraints: Satellite communication check* [C-37]

The planner will perform a check to ensure that satellite communication is maintainable throughout the mission.

3.3 **Upgrade Capability**

[H] *Open architecture to support future payloads and payload capabilities* [C-38]

The planner will implement an open architecture to support future payloads and payload capabilities.

[H] *Open architecture to support rotary wing, VTOL, or other Unmanned Aerial Vehicle (UAV) systems* [C-39]

The planner will implement an open architecture to support rotary wing, Vertical Take-Off and Landing (VTOL), or other UAV systems.

[L] *Portable to other military computing platforms* [C-40]

The planner will be portable to other military computing platforms (e.g., Silicon Graphics).

4. **Acronym List**

6-DOF	6 Degrees of Freedom
ADRG	Arc Digitized Raster Graphic
AFMSS	Air Force Mission Support System
AMPS	Aviation Mission Planning System
AV	Air Vehicle
CADRG	Compressed ADRG
DII	Defense Information Infrastructure
DoD	Department of Defense
DFAD	Digital Feature Analysis Data
DTED	Digital Terrain Elevation Data
EO/IR	Electro-Optical/Infrared
FOV	Field of View
GDT	Ground Data Terminal
GPS	Global Positioning System
ID	Identification
IFF	Identify Friend or Foe
JMTK	Joint Mapping Tool Kit
LOS	Line of Sight
MGRS	Military Grid Reference System
NIMA	National Imagery and Mapping Agency
SAR	Synthetic Aperture Radar
TAMPS	Tactical Aircraft Mission Planning System
TCS	Tactical Control System
UAV	Unmanned Aerial Vehicle
UTM	Universal Transverse Mercator
VCR	Video Cassette Recorder
VTOL	Vertical Take-Off and Landing